

Workshop Manual

Technical Data

A
2(0)

MD22, TMD22, TAMD22

Workshop Manual

Marine Engines

**MD22A, MD22L-A, MD22L-B, MD22P-B, TMD22A,
TMD22-A, TMD22-B, TMD22P-C, TAM22P-B**

Specifications, Technical Data

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Safety information


Introduction


This Workshop Manual contains technical data, descriptions and repair instructions for Volvo Penta products or product versions contained in the contents list. Ensure that the correct workshop literature is being used.

Read the safety information and the Workshop Manual “General Information” and “Repair Instructions” carefully before starting work.

Important


In this book and on the engine, you will find the following special warning symbols.


 **WARNING!** If these instructions are not followed there is a danger of personal injury, extensive damage to the product or serious mechanical malfunction.

 **IMPORTANT!** Used to draw your attention to something that can cause damage, product malfunction or damage to property.

Note! Used to draw your attention to important information that will facilitate work or operations.


Below is a summary of the risks and safety precautions you should always observe or carry out when operating or servicing the engine.


 Immobilize the engine by turning off the power supply to the engine at the main switch (switches) and lock it (them) in the OFF position before starting work. Set up a warning notice at the engine control point or helm.


 Generally, all servicing should be carried out with the engine switched off. However, some work, for example certain adjustments, require that the engine is running when they are carried out. Approaching a running engine is dangerous. Loose clothing or long hair can catch in rotating parts and cause serious personal injury.


If working in proximity to a running engine, careless movements or a dropped tool can result in personal injury. Avoid burns. Take precautions to avoid hot surfaces (exhausts, turbochargers, charge air pipes and starter elements etc.) and liquids in supply lines and


hoses when the engine is running or has been turned off immediately prior to starting work on it. Reinstall all protective parts removed during service operations before starting the engine.


 Check that the warning or information decals on the product are always clearly visible. Replace decals that have been damaged or painted over.


 Engines with turbochargers: Never start the engine without installing the air cleaner (ACL) filter. The rotating compressor in the turbocharger can cause serious personal injury. Foreign objects entering the intake ducts can also cause mechanical damage.











 Never use start spray or similar to start the engine. An explosion may occur in the inlet manifold. Danger of personal injury.


 Avoid opening the filler cap for engine coolant system (freshwater cooled engines) when the engine is still hot. Steam or hot coolant can spray out. Open the coolant filler cap carefully and slowly to release the pressure before removing the cap completely. Take great care if a cock, plug or engine coolant line must be removed from a hot engine. It is difficult to anticipate in which direction steam or hot coolant can spray out.


 Hot oil can cause burns. Avoid getting hot oil on the skin. Ensure that the lubrication system is not under pressure before carrying out any work. Never start or operate the engine with the oil filler cap removed, otherwise oil could be ejected.


 Stop the engine and close the seacock valve before carrying out operations on the engine cooling system.


 Only start the engine in a well-ventilated area. If operating the engine in an enclosed space, ensure that exhaust gases and crankcase ventilation emissions are ventilated out of the working area.

-  Always use protective goggles where there is a danger of pieces of metal, sparks from grinding, acid or other chemicals being thrown into your eyes. Your eyes are very sensitive. Injury can lead to loss of sight!
-  Avoid skin contact with oil! Long-term or repeated contact with oil can remove the natural oils from your skin. The result can be irritation, dry skin, eczema and other skin problems. Used oil is more dangerous to health than new oil. Use protective gloves and avoid using oil-soaked clothes and rags. Wash regularly, especially before meals. Use the correct barrier cream to prevent dry skin and to make cleaning your skin easier.
-  Most chemicals used in products (engine and transmission oils, glycol, petrol and diesel oil) and workshop chemicals (solvents and paints) are hazardous to health. Read the instructions on the product packaging carefully! Always follow safety instructions (using breathing apparatus, protective goggles and gloves for example). Ensure that other personnel are not unwittingly exposed to hazardous substances (by breathing them in for example). Ensure that ventilation is good. Handle used and excess chemicals according to instructions.
-  Be extremely careful when tracing leaks in the fuel system and testing fuel injection nozzles. Use protective goggles! The jet ejected from a fuel injection nozzle is under very high pressure. It can penetrate body tissues and cause serious injury. Danger of blood poisoning.
-  All fuels and many chemicals are inflammable. Ensure that a naked flame or sparks cannot ignite fuel or chemicals. Combined with air in certain ratios, petrol, some solvents and hydrogen from batteries are easily inflammable and explosive. Smoking is prohibited! Ensure that ventilation is good and that the necessary safety precautions have been taken before carrying out welding or grinding work. Always have a fire extinguisher to hand in the workplace.
-  Store oil and fuel-soaked rags and fuel and oil filters safely. In certain conditions, oil-soaked rags can spontaneously ignite. Replaced fuel and oil filters are environmentally harmful waste and should be disposed of at proper disposal areas together with engine and transmission oil, contaminated fuel, old paint, degreasing agents, and cleaning residue.
-  Never allow a naked flame or electric sparks near the batteries. Never smoke in the vicinity of the batteries. The batteries give off hydrogen gas during charging which when mixed with air can form an explosive gas - oxyhydrogen. This gas is easily ignited and highly volatile. Incorrect connection of the battery can cause a single spark which is sufficient to cause an explosion with resulting damage. Do not disturb battery connections when starting the engine (spark risk) and do not lean over batteries.
-  Always ensure that the Plus (positive) and Minus (negative) battery leads are correctly installed on the corresponding terminal posts on the batteries. Incorrect installation can result in serious damage to electrical equipment. Refer to wiring diagrams.
-  Always use protective goggles when charging and handling the batteries. The battery electrolyte contains extremely corrosive sulfuric acid. If this comes into contact with the skin, wash immediately with soap and plenty of water. If battery acid comes into contact with the eyes, immediately flush with copious amounts of water and obtain medical assistance.
-  Turn off the engine and switch off the power at the main switch(es) before carrying out work on the electrical system.

 Use the lifting eyes mounted on the engine / reverse gear when lifting the drive unit. Always check that lifting equipment is in good condition and has sufficient load capacity to lift the engine (engine weight including reverse gear and any extra equipment installed). Use an adjustable lifting beam or lifting beam specifically for the engine to raise the engine to ensure safe handling and to avoid damaging engine parts installed on the top of the engine. All chains and cables should run parallel to each other and as perpendicular as possible in relation to the top of the engine. If extra equipment is installed on the engine, thereby altering its center of gravity, a special lifting device is required to achieve the correct balance for safe handling. Never carry out work on an engine suspended on a hoist.

 Never remove heavy components alone, even where secure lifting equipment such as secured blocks are being used. Even where lifting equipment is being used, it is best to carry out the work with two people; one to operate the lifting equipment and the other to ensure that components are not trapped and damaged when being lifted. When working on-board, ensure that there is sufficient space to remove components without danger of injury or damage.

 Components in the electrical system, ignition system (gasoline engines) and fuel system on Volvo Penta products are designed and constructed to minimize the risk of fire and explosion. The engine must not be run in areas where there are explosive materials.

 Always use fuels recommended by Volvo Penta. Refer to the Instruction Book. The use of other grades of fuel can damage the engine. On a diesel engine, poor quality fuel can cause the control rod to seize and the engine to overrev with the resulting risk of damage to the engine and personal injury. Poor fuel quality can also lead to higher maintenance costs.

General information

About the workshop manual

This Service Manual contains technical specifications, descriptions and instructions for the repair of the following engines in standard format: MD22A, MD22L-A, MD22L-B, MD22P-B, TMD22A, TMD22-A, TMD22-B, TMD22P-C, TAM22P-B. This Service Manual can show operations carried out on any of the engines listed above. As a result, the illustrations and pictures in the manual that show certain parts on the engines, do not in some cases apply to all the engines listed above. However, the repair and service operations described are the same in all essential details. Where they are not the same, this is stated in the manual. Where the difference is considerable, the operations are described separately. The engine designation and engine number are displayed on the identification plate. The engine designation and number should be given in all correspondence about the engine.

This Workshop Manual has been developed primarily for Volvo Penta service workshops and qualified personnel. Persons using this book are assumed to have a grounding in marine drive systems and be able to carry out related mechanical and electrical work.

Volvo Penta is continuously developing their products. We therefore reserve the right to make changes. All the information contained in this book is based on product data available at the time of going to print. Any essential changes or modifications introduced into production or updated or revised service methods introduced after the date of publication will be provided in the form of Service Bulletins.

Spare parts

Replacement parts for electrical and fuel systems are subject to statutory requirements (US Coast Guard Safety Regulations for example). Volvo Penta Genuine parts meet these requirements. Any type of damage which results from the use of non-original Volvo Penta replacement parts for the product will not be covered under any warranty provided by Volvo Penta.

Certificated engines

If you own an engine certificated for any area where exhaust emissions are regulated by law, the following is important:

Certification means that an engine type is inspected and approved by the authorities. The engine manufacturer guarantees that all engines manufactured of that type correspond to the certified engine.

This places special requirements for maintenance and service as follows:

- The maintenance and service intervals recommended by Volvo Penta must be observed.
- Only genuine Volvo Penta replacement parts may be used.
- The service of injection pumps and injectors or pump settings must always be carried out by an authorized Volvo Penta workshop.
- The engine must not be modified in any way except with accessories and service kits approved by Volvo Penta.
- No modifications to the exhaust pipes and air supply ducts for the engine room may be undertaken.
- Seals may only be broken by authorized personnel.

In addition, the general instructions contained in the Instruction Manual concerning operation, service and maintenance must be followed.



IMPORTANT! Late or inadequate maintenance / service or the use of spare parts other than Volvo Penta original spare parts will invalidate AB Volvo Penta's responsibility for the engine specification being in accordance with the certificated variant.

Volvo Penta accepts no responsibility or liability for any damage or costs arising due to the above.

Specifications

Technical Data: General

No. of cylinders	4
Cylinder configuration	In-line engine
Cycle	Four stroke
Intake system	Naturally aspirated engine or turbocharged
Combustion system	Direct injection
Cylinder bore	84.5 mm
Cylinder stroke	88.9 mm
Compression ratio	
MD22	18.1:1
MD22L	17.0:1
MD22P, TMD22	18.0:1
TAMD22	17.5:1
Compression at starter motor speed	2100-3500 kPa
Overall cylinder displacement	1.994 liters
Firing order	1-3-4-2
Valve clearances, cold engine:*	
– Intake	0.25-0.35 mm
– Exhaust	0.35-0.45 mm

* Only adjust if the clearance is outside the limits:

– Intake	0.20-0.40 mm
– Exhaust	0.30-0.50 mm

When the cylinder head screws are tightened, the valve clearance reduces by 0.05 mm. If the valve clearance is checked when the cylinder head is not tightened against the cylinder block, the clearances must be as follows:

– Intake	0.30/0.40 mm
– Exhaust	0.40/0.50 mm

If the valve clearance is checked when the cylinder head is not tightened, use the clearances below when calculating shims:

– Intake	0.35 mm
– Exhaust	0.45 mm

Lubricating oil pressure (minimum value at maximum engine speed (RPM) and normal engine coolant temperature (ECT))

250 kPa

Direction of rotation

Clockwise, viewed from in front

Cylinder block

Pistons

Type	"Swirl lip" combustion chamber, controlled expansion, insert for top ring groove, center displaced piston pin
Diameter at piston bolt hole	28.004-28.010 mm
Distance between height classes	
Production class 1 to 6	0.05 mm
Service classes 3 and 6	0.15 mm
Piston height over cylinder block surface	0.46-0.65 mm
Height of groove for the upper ring	
MD22L, MD22, TMD22	2.10-2.12 mm
TMD22P, TAMD22	3.5 mm
Height of groove for the 2 nd ring	
MD22L, MD22, TMD22	1.81-1.83 mm
TMD22P, TAMD22	2.06-2.08 mm
Height of groove for the 3 rd ring	3.03-3.05 mm
Oversized piston	0.50 mm at the diameter

Piston rings

Upper compression ring	
MD22L, MD22, TMD22	Thin shaped (barrel face), molybdenum insert, internal face on top surface.
TMD22P, TAMD22	Keystone ring
2 nd compression ring	Conical surface, alloy cast iron
Oil scraper ring	Spring-loaded, chromed surface
Height,	
upper ring	1.978-1.990 mm
2 nd ring	1.73-1.74 mm
3 rd ring	2.98-2.99 mm
Play in groove	
upper ring	0.11-0.14 mm
2 nd ring	0.07-0.10 mm
3 rd ring	0.04-0.07 mm
Ring gap	
upper ring MD22L, MD22, TMD22	0.28-0.56 mm
upper ring TMD22P, TAMD22	0.30-0.50 mm
2 nd ring MD22L, MD22, TMD22	0.28-0.56 mm
2 nd ring TMD22P, TAMD22	0.60-0.80 mm
3 rd ring	0.23-0.56 mm

Piston bolts

Type	Moving
Outer diameter	27.995-28.000 mm
Play in piston bolt position, piston	0.004-0.015 mm

Cylinder block

Height between the cylinder head surface and contact surface for the bearing cap	236.85-236.98 mm
Cylinder bore	84.442-84.469 mm
Maximum permitted wear, cylinder bore	0.15 mm
Oversize, cylinder bore	84.942-84.969 mm
Diameter, bearing recess for main bearings	60.703-60.719 mm

Cylinder head

Valve seat angle	45°
Diameter of hole for camshaft	48.018-48.057 mm
Diameter of hole for valve guides	11.98-12.00 mm
Diameter of hole for valve lifter	31.750-31.775 mm
Pressure during leak test	200 kPa
Maximum permitted cylinder head out-of-true	0.10 mm
Cylinder head height	
MD22L, MD22, TMD22	120.0-120.1 mm
TMD22P, TAMD22	119.4-119.5 mm
Permitted machining of cylinder head surface	
MD22L, MD22, TMD22	0.20 mm (cylinder head minimum height 119.85 mm)
TMD22P, TAMD22	0.20 mm (cylinder head minimum height 119.25 mm)

Crank movement**Crankshaft**

Diameter, main bearing journals	56.99-57.01 mm
Maximum permitted play and ovality for main bearing journals:	0.03 mm
Width,	
front bearing journal	27.9-28.6 mm
center bearing journal	32.35-32.43 mm
other bearing journals	30.5-31.1 mm
Diameter, big end journals	53.99-54.01 mm
Maximum permitted play and ovality for big end journals:	0.03 mm
Width, big end journals	27.45-27.65 mm
Crankshaft, axial clearance	0.03-0.26 mm
Diameter, rear flange	88.84-88.95 mm
Maximum permitted diameter, rear flange (service)	88.59 mm
Front stuffing box diameter	34.965-34.995 mm
Minimum permitted diameter, front stuffing box (service)	34.72 mm
Diameter, camshaft pulley	31.98-32.00 mm
Diameter, socket for guide bearing	28.58-28.60 mm
Depth, socket for guide bearing	20.8 mm
Lower dimensions, main bearings and big end journals	-0.30 mm

Main bearing shells

Type	Steel coated, aluminum tin
Bearing width,	
center bearing	24.27-24.52 mm
other bearings	22.35-22.60 mm
Bearing thickness	1.828-1.835 mm
Inner diameter	57.033-57.063 mm
Bearing clearance	0.023-0.073 mm
Permissible lower dimensions of bearings	-0.30 mm

Big end bearing shells

Type	Steel coated, copper-lead
Thickness	1.815-1.825 mm
Inner diameter	54.033-54.066 mm
Bearing clearance	0.023-0.076 mm
Permissible lower dimensions of bearing shells ...	-0.30 mm

Crankshaft thrust washers

Type	Steel coated, aluminum solder
Position	Both sides of the center bearing
Thickness	2.31-2.36 mm

Connecting rods

Type	H-section
Diameter, bearing position of the big end shells ...	57.683-57.696 mm
Diameter, bearing position of the connecting rod bushing	30.93-30.96 mm
Distance between bearing centers	144.98-145.03 mm

Connecting rod bushing

Type	Steel coated, lead bronze
Inner diameter (reamed)	28.005-28.018 mm
Clearance between connecting rod bushing and piston bolt	0.05-0.023 mm

Alignment of connecting rod (A)

The holes for the big end bearing shells and the connecting rod bushing must be at right angles and parallel with each other within a ± 0.25 mm tolerance, measured with a mandrel at a distance of 127 mm on each side of the connecting rod. With the connecting rod bushing installed, the tolerance is reduced to ± 0.06 mm.

Flywheel

Maximum radial runout	0.30 mm total read off on the dial indicator
Max. axial runout	
for every 25 th mm radial clearance	
between the crankshaft and the gauge tip on the indicator.	0.03 mm total read off on the dial indicator

Flywheel cover

Concentric and parallel limits	0.15 mm total read off on the dial indicator
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Valve mechanism

Valve guides

Inner diameter (reamed in position)	7.450-7.463 mm
Outer diameter	12.04-12.06 mm
Valve guide interference in cylinder head	0.04-0.08 mm

Intake valves

Valve stem diameter	7.41-7.42 mm
Clearance valve stem – valve guide	0.03-0.05 mm
Maximum permitted clearance valve stem – valve guide	0.13 mm
Valve crown diameter	37.10-37.25 mm
Valve contact angle	44° 30' (91° total angle)
Total length	93.72 - 93.97 mm
Sealing equipment	Rubber seal installed on the valve guide.
Valve crown depth position under cylinder head face MD22L, MD22, TMD22	0.90-1.24 mm
TMD22P, TAMD22	0.25-0.59 mm

Exhaust valves

Valve stem diameter	7.39-7.41 mm
Clearance valve stem – valve guide	0.04-0.07 mm
Maximum permitted clearance valve stem – valve guide	0.13 mm
Valve crown diameter	33.55-33.70 mm
Valve contact angle	44° 30' (91° total angle)
Total length	93.72- 93.97 mm
Sealing equipment	Rubber seal installed on the valve guide.
Valve crown depth position under cylinder head face MD22L, MD22, TMD22	1.30-1.64 mm
TMD22P, TAMD22	0.65-0.91 mm

Valve springs

Installed length	34.7 mm
Spring loading when installed	198 N
Number of active spring coils	4.5
Number of damper coils	0
Direction of winding	Left
Color coding	Orange

Valve lifters and shims

Material	Steel
Outer diameter of valve lifter	31.725-31.745 mm
Valve lifter clearance in cylinder head	0.005-0.050 mm
Thickness of the head of the valve lifter	6.85-6.93 mm
Total length	25.7-26.3 mm
Thickness of shims	Series of shims from 2.286 mm to 3.400 mm

Camshaft

Diameter of front and rear bearing journal	47.693-47.975 mm
Diameter of center bearing journal	47.958-47.975 mm
Clearance of the bearing journals in the holes:	
– Front and rear	0.043-0.094 mm
– Center	0.043-0.099 mm
Diameter of pulley hub	36.58-36.61 mm
Cam lift, at 0 mm valve clearance (intake/exhaust)	
MD22L	9.1/9.4 mm
MD22P, TMD22, TAMD22	9.6/9.6 mm
Axial clearance	0.11-0.27 mm
Maximum permitted axial clearance in operation..	0.50 mm
Depth of socket for thrust washer	6.06-6.12 mm

Camshaft thrust washer

Type	180° washer installed in camshaft cover
Thickness	5.90-5.95 mm
Installation parameter for thrust washer in socket in camshaft cover	± 0.05 mm

Pulley for crankshaft

Number of teeth	24
Hole diameter	32.010-32.035 mm
Pulley clearance on crankshaft	0.010-0.055 mm

Pulley and hub for crankshaft

Number of teeth	48
Hole diameter in hub	36.62-36.65 mm
Hub clearance on crankshaft	0.01-0.07 mm

Pulley for fuel injection pump

Number of teeth	48
Hole	Conical
Setting tooth and marking letter	
MD22, MD22L	"A"
TMD22, TAMD22	"B"

Idler pulley for timing belt

Outer diameter	79.8-80.2 mm
Internal radial clearance	0.005-0.025 mm

Tension pulley for timing belt

Outer diameter	59.8-60.2 mm
Internal radial clearance	0.005-0.025 mm
Timing belt tension (according to gauge)	
New belt	425-465 N
If the tension of the existing (used) belt has fallen to 270 N or lower, adjust to	340-370 N

Lubrication system

Lubricating oil pump

Type	Differential rotor, installed around the front end of the crankshaft
Number of teeth	Inner rotor 10, outer rotor 11
Clearance,	
outer rotor-housing	0.30-0.36 mm
inner rotor-outer rotor	0.025-0.082 mm
Axial clearance,	
inner rotor	0.030-0.075 mm
outer rotor	0.05-0.10 mm

Relief valve, oil pressure

Valve opening pressure	414 kPa
Hole diameter, control sleeve	14.21-14.25 mm
Outer diameter, plunger	14.160-14.186 mm
Clearance plunger-sleeve	0.024-0.090 mm
Spring length (integrated)	30.4 mm
Spring loading (integrated)	51.1 N

Fuel system

Injection pump

Make	Bosch
Type	EPVE
Rotational direction, (viewed from drive end)	Clockwise
Exit point for cylinder 1	"A"
Pump element lift, motor TDC	
MD22	1.37 ±0.02 mm
MD22L	1.42 ±0.02 mm
TMD22	1.26 ±0.02 mm
TMD22P	1.22 ±0.02 mm
TAMD22	1.10 ±0.02 mm

Injector

Opening pressure,	
MD22L (Code RG)	22.8±10 MPa
MD22 (Code JD)	22.8±10 MPa
TMD22 (Code JC)	22.8 ±5 MPa
TMD22P, TAMD22 (Code RY)	23.5 ±5 MPa

Feed pump

Type	A.C. Delco, type YD
Drive method	Eccentric from camshaft
Static pressure (no power supply)	41-69 kPa

Fuel filter

Make	Bosch
Type	Spin-on

Turbocharging system

Turbocharger (TC)

Make	Garret
Lubrication system	Force-feed lubrication from the engine

Cooling system

Circulation pump

Type	Centrifugal pump, belt driven
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Sea water pump

Make	Jabco
Type	Rubber impeller
Drive	Belt drive

Thermostat

Type	Wax filled thermostat, by-pass version
Starts opening at	77°-85°C
Fully open at	92°-98°C
Valve lift height, fully open	9.1 mm

Electrical system

Generator

Make	Valeo
Type	A13N 147M
Marking data	12V/60A (early version 12V/50A)
Direction of rotation	Clockwise, viewed from drive end

Starter motor

Make	Lucas
Type	M80R
Voltage	12V
Number of teeth on the drive	10
Maximum resistance of engine starter cable at 20°C	0.0017 ohm
Brush length:	
New	9.0 mm
Minimum permissible, used	3.5 mm

Glow plugs

Make	Bosch
Current after 20 seconds	12A
Probe length	23 mm

Tightening torque

	Thread	Torque (Nm)'
Cylinder head assembly		
Bolts, cylinder head	M 12	(see next page)
Bolts, camshaft cover	M 8	22
Piston and connecting rod assembly		
Nuts, big ends	11/32 UNF	47
Crankshaft assembly		
Screws, main bearing	M 12	112
Screws, crankshaft pulleys	M 14	180
Domed screws, crankshaft pulley	M 6	10
Screws, housing for rear stuffing box	M 10	43
Timing cover and drive		
Screws, timing cover	M 5	3
	M 6	6
	M 8	10
Screws, hub for camshaft pulley	M 12	85
Screws, camshaft pulley to hub	M 8	22
Domed screw, tension pulley	M 10	43
Screws, idler pulley	M 10	43
Intake system		
Screws, intake and exhaust manifold	M 8	22
Lubrication system		
Plug, lubricating oil sump	1/4 BSP	43
Screws, lubricating oil pump	M 6	9
	M 8	22
	M 4	4
Screws, rear face of oil pump	M 4	4
Screws, filter head to oil pump	M 8	22
Screws, lubricating oil sump	M 6	12
Fuel injection system		
Nuts, high pressure fuel lines	M 12	18
Screws, injector holder	M 10	43
Fuel feed pump screws	M 8	22
Screws, mounting bracket for fuel injection pump	M 10	43
Nut, pulley for injector pump	M 14	60
Nuts for flange for fuel injection pump	M 8	22
Cooling system		
Screws, water pump	M 8	22
	M10	48
Screws, seawater pump	M 6	9
Domed screws, drive adapter for seawater pump	M 6	9
	M 10	43
Flywheel and flywheel housing		
Screws, flywheel to crankshaft	7/16 UNF	65
Screws, flywheel housing	M 8	22
	M 10	43
	M 12	81
Electrical system		
Nuts, generator (GEN) pulley	M 17	60
Glow plugs	M 12	20

* The above tightening torques apply to components lightly lubricated with clean engine oil prior to installation.

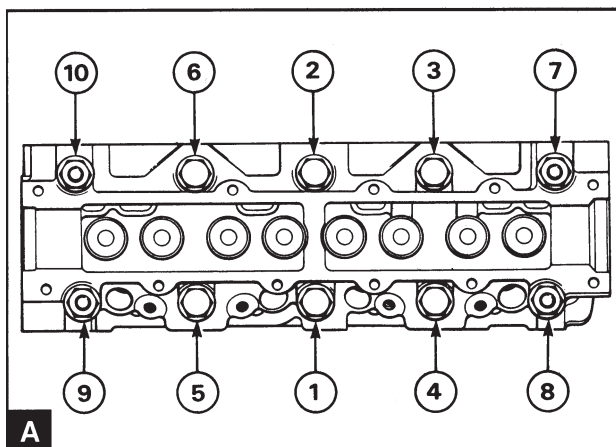
Cylinder head screws

Tighten the screws in 3 stages according to diagram A.

1st tightening: 50 Nm

2nd tightening: 100 Nm

3rd tighten by 90° in one operation



Tightening diagram

Notes

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Customer Support
Dept. 42200
SE-405 08 Gothenburg
Sweden

